Canadian Studies in Population, Vol. 17 (1), 1990, pp. 107-132

INTERDEPENDENCE OF TRANSITIONS AMONG MARITAL AND PARITY STATES IN CANADA

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Résumé – La somme des naissances réduites de plusieurs pays développés s'étant stabilisée en dessous du niveau de remplacement pendant plus d'une décennie, les intérêts dans la recherche se sont deplacés en quittant les enquêtes sur les mesures sommaires telles que le nombre moyen d'enfants pour une enquête plus pertinante des changements en clendrier de fécondité et leur dépendance à l'égard des changements en tendances matrimoniales. Cette étude illustre une telle enquête en utilisant les histoires matrimoniales et génésiques provenant de l'Enquête Canadienne en Fécondité de 1984, et examine les tendances sur les cohortes en calendrier et type de transitions parmi les états matrimoniaux et ceux de la parité. On a constaté que le changement le plus évident sur les cohortes réside dans la première transition même faite après l'âge de 15 ans, soit au premier mariage ou à la première cohabitation. La première transition affecte substantiellment les transitions subséquentes et aux états matrimoniaux et à ceux de la parité.

Abstract – With total fertility rates in many developed countries stabilized below the replacement level for more than a decade, research interests naturally shift from investigations of summary measures, such as mean number of births, to a more relevant investigation of changes in timing of fertility and their dependence on changes in marital patterns. This paper exemplifies one such investigation, making use of the marital and fertility histories obtained through the Canadian Fertility Survey 1984, and examines the trends over cohorts in timing and type of transitions among marital and parity states. It is found that the most conspicuous change over cohorts lies in the very first transition made after age 15, either to first marriage or to first cohabitation. The first transition substantially affects the subsequent transitions to both marital and parity states.

Key Words – **retrospective data, life history analysis, semi-Markov and non-Markov processes, coupled states**

Introduction

Total fertility rates in many developed countries have been below replacement levels for the last two decades and seem to have reached a plateau showing little sign of change. Canada is no exception to this. There is no doubt, however, that there are changes in nuptiality and fertility behaviours which, along with many socioeconomic opportunities available to women, result in a variety of lifestyles. For example, there is ample evidence that there is less felt-need of marriage as a prerequisite for procreation, an increasing incidence of cohabitation and childlessness, an increasing difference in the timing of first to third births (for the Canadian situation, see Balakrishnan, 1986; Grindstaff, 1985; Romaniuc, 1984), less significance of age at first birth and short birth interval on lifetime fertility (Balakrishnan *et al.*, 1988; Teachman, 1985; Trussell and Menken, 1978), and so on. In such a context of rapid and interdependent changes in nuptiality and fertility, traditional summary measures are of little use in detecting these underlying changes. A more relevant investigation of changes in fertility has to take on a new dimension with parity progressions dependent on marital patterns, as well as other factors which constitute various lifestyles for which women are striving.

In particular, the timing and frequency[1] of births and their dependence on marital patterns are becoming more relevant as an area of investigation in fertility. There are a number of reasons for this. When the desired family size is low, births can be timed at various intervals given the long reproductive span of more than 30 years and given a very efficient use of contraception. Added to these are the many changes in educational level, female labour force participation, attitudes towards family life and sex roles. More than ever before, women have a greater freedom and confidence in planning not only their family size, but also the type and timing of family formation. Women can plan a longer schooling, a career, and a later marriage and still achieve the desired family size; or, women can plan early childbearing, not necessarily early union formation, and then go back to school or enter the work force (Bhrolchain, 1986).

With the multitude of choices at women's disposal these days, women having the same number of children during their lifetime may have taken entirely different paths in terms of timing of union and timing of births. Therefore, a relevant investigation of fertility (at least in developed societies) has to be built on these varieties of paths that women are free to take. In other words, a relevant fertility analysis needs three main types of information: *timing, sequence* and *number* of births and of changes in marital states – these three types constituting what is commonly known as life history or event history data.

Our earlier study on Canadian fertility (Rajulton *et al.*, 1990) showed the advantages of making use of sample path information in order to bring out the underlying dynamic changes in fertility. However, our previous work based on a semi-Markov model was made less complex and more manageable by considering transitions only among a system of parity states or a state space defined by the states "Parity 0", "Parity 1", "Parity 2", "Parity 3" and "Sterility" (standing for sterilized state), where the last was treated as an absorbing state (that is, once the state is entered, no transition to other states is possible). There is no doubt that changes in patterns of marital states have a profound influence on the timing and intensity of births. This study attempts to fill the lacuna in our previous work and to obtain a more complete picture of changes that have taken place among Canadian women in their transitions among both marital and parity states.

Thus, the main objective of this study is to construct and to examine duration-dependent transition probabilities in a system of *coupled* marital and parity states for various birth cohorts of women in the sample. The techniques involved are outlined later in this article (for more details, see Rajulton, 1989). A system of coupled states allows a change in a pair of qualitative variables, unlike a system of simple states where only a change in a single qualitative variable is considered. In general, the technique of coupling states allows an examination of changes in a system of *dynamically interdependent* states (for details, see Tuma and Hannan, 1984). It is clear that marital and fertility states profoundly affect each other; a change in parity state depends on a woman's marital state, and vice versa.

Notes on the Data and on the Use of Retrospective Information

The Canadian Fertility Survey was conducted in 1984, in which a national probability sample of 5,315 women of all marital states in their reproductive years of 18-49 were interviewed by telephone, using random digit dialing procedure. The response rate was 70 per cent, with the loss arising from household contact (20 per cent) and eligible respondent levels (13 per cent), which is average or better than those obtained in similar telephone surveys and only slightly lower than those found in face-to-face surveys. There is no way of checking whether the non-respondents differ from the respondents as regards the behaviour examined in this study. Retrospective information was obtained from these women regarding their fertility history, marital and work histories, contraception, and their attitudes towards sex and family life, in addition to the usual information on socioeconomic characteristics at the time of survey. A few women were excluded from the following analysis since they were not able to provide information on exact dates of occurrence of events of interest. A total of 5,282 women were included in this analysis.

Table 1 presents the observed percentages of the number of transitions, classified by cohorts, among marital and parity states which will be defined in the following section. Higher percentages are associated with the normal events such as first marriage and births of order one to three. Thus, for example, 73 per cent of sample women were first married, 64 per cent had first births and 49 per cent had second births. As well, 29 per cent of sample women had (first) cohabited, 8 per cent were divorced and 24 per cent had been sterilized.

TABLE 1. OBSERVED PERCENTAGES OF THE NUMBER OF EVENTS EXPERIENCED BY WOMEN, CLASSIFIED BY BIRTH COHORTS, CFS 1984

	Cohorts			
	18-24	25-34	35-49	Total
No.of women	1308	1906	2067	5282
No.of events in percentages (to the No. of women):				
First Cohabit.	32.1	39.4	18.0	29.2
First marrriages	27.7	80.5	95.0	73.1
First separations	2.8	12.6	15.6	11.4
First divorces	0.6	8.0	11.8	7.6
Widowhood	0.1	0.9	2.8	1.4
First births	20.5	68.4	88.0	64.2
Second births	6.9	47.1	76.0	48.5
Third births	1.2	13.2	43.9	22.3
Sterilization	0.7	14.0	47.1	23.7

An analyst is confronted with two main problems in dealing with *incomplete* maternity histories provided by a retrospective survey of the type considered here: namely, the problems of *censoring* and of *selectivity*. Both these problems can be handled by life table techniques (Rodriguez and Hobcraft, 1980). The problem of censoring is handled by considering incomplete exposure in the calculation of probabilities, where one combines the experience of those women who made a specific transition from a specific origin state and of those who did not. The transition probabilities presented in this study have all been corrected for censoring. In addition, the problem of selectivity can be handled by constructing separate life tables for women reaching each origin state at different ages; that is, by constructing age-and-duration-dependent transition probabilities. Our previous work (Rajulton *et al.*, 1990) made use of the age-and-duration-dependent probabilities. However, this study has to forego the use of age for the sake of accomodating heterogeneity due to past history of transitions. Small sample sizes do not allow the inclusion of both aspects of heterogeneity.

The System of Transitions among Marital and Parity States

We shall define a finite discrete state space *S* consisting of marital and parity states among which women transit: single (SING), first cohabitation (FCOH), first marriage (FMAR), separated (SEP), divorced (DIV), first birth (FBIR), second birth (SBIR), third birth (TBIR) and sterilized (STER). The first five states are with respect to changes in marital status, and the remaining four are with respect to parity progressions. All women start the marital and parity histories in the single state as never married, never cohabited and nulliparous. The separation state includes women who no longer live with their (marital) spouse but have not yet gone through the formal process of divorce. Separation of cohabiting partners is not considered for analysis since the survey collected the necessary information only on the formation of first cohabitation but not on its dissolution nor on subsequent cohabitations. We have dropped the marital state "widowed" because the number of sample women who experienced widowhood is too small (see Table 1) to allow a life table construction.

The timing, sequence and number of transitions made by women among these states are retrieved from the fertility and marital histories gathered by the survey. We shall assume that all women enter the state SING at age 15, and thereafter each woman generates a sample path, which is a record of the states she visits one after another along with the duration spent in each state.

A complete set of data ready for analysis consists of sample paths of women in the sample. Events are examined in sequences up to the first divorce as regards the marital state and up to the third birth as regards parity. Thus, the very few women who were married and had births before age 15, as well as the histories of those who went on to have second marriages or more than three children, are not examined in this study.

The inclusion of the state STER in the state space requires an explanation. It is neither a marital state nor a parity state. Though we are interested in examining the interdependence of fertility and nuptiality, we focus our attention primarily on fertility, that is, transition from one parity to the next. A proper way of calculating these probabilities would exclude the women who are not exposed to the risk of pregnancy. This concerns those who become sterile either voluntarily or involuntarily. There is no way of identifying the small proportion of three or four per cent who are involuntarily sterile (as in any population). However, an appreciable proportion (24 per cent) of women report that they have undergone tubal ligation and/or hysterectomy or other surgical procedures rendering them sterile. As information on the date of tubal ligation and other surgical procedures resulting in sterilization was also collected in the survey, these women are considered to have made a transition from one of the marital or parity states to the state STER at the reported time. Once a woman enters this state, she is assumed to enter into a partially absorbing state – partial in the sense that no transition can be made to any higher parity state, but a transition to another marital state is possible.[2]

In order to consider changes in a system of two dynamically interdependent subsystems consisting of marital and parity states respectively, we introduce coupled states rather than single states as given above. The two subsystems marital status and parity status are denoted by S_M and S_p, and a pair of random variables X_{Mn} and X_{Pn} are used to denote the states occupied at the n-th step in each subsystem. These random variables take distinct values denoted by positive integers from 1 to S_j, where S_j is the size of the finite state space of the j-th subsystem, $j = M$ or P. Elementary principle of combinatorics suggests that the number of distinct values which the system of coupled states can take is equal to $\Pi_{j=M,P}\, S_j$.

Specifically, the random variable X_{Mn} denotes the marital state taking values 1 = SING, 2 = FCOH, 3 = FMAR, 4 = SEP and 5 = DIV. Similarly, the random variable X_{Pn} takes values 1 = Parity 0, 2 = Parity 1, 3 = Parity 2, 4 = Parity 3, 5 = STER. We have, therefore, 5 x 5 = 25 different coupled states (X_{Mn}, X_{Pn}) in the system, namely (1,1), (1,2), (1,3), (1,4), (1,5), (2,1), (2,2) ... and so on. All women are assumed to enter the coupled state (1,1) at age 15. Some women will make their first move to the coupled state

(2,1), some to (3,1) and others to (1,2). Though there are 25 different coupled states, not all of them are meaningful nor are all of them realizable; only a few of them would be relevant in practical situations. For example, transitions from (1,1) to (1,5) or from (3,1) to (3,3) are not relevant.

Analogous to the definitions normally used in the case of Markov or semi-Markov modeling, we shall consider the triplet (s_{Mn}, s_{Pn}, y_n) where (s_{Mn}, s_{Pn}) is the coupled state occupied by a woman at the n-th step after a duration of y_n units in the previous coupled state. If we denote by $w_i = (s_{Mi}, s_{Pi}, y_i)$ the i-th transition, then starting from $w_0 = (s_{M0}, s_{P0})$, we follow a woman's history as follows: $w_1 = (s_{M1}, s_{P1}, y_1)$, $w_2 = (s_{M2}, s_{P2}, y_2)$, and so on. We shall simplify the notation for the sake of ease in reading the text and the tables by denoting w_0 = SING, w_1 = SING-FCOH or SING-FMAR or SING-FBIR, w_2 = SING-FCOH-FMAR or SING-FCOH-FBIR, SING-FCOH-STER, SING-FMAR-FBIR, and so on, provided the basic notions involved in a system of coupled states are kept in mind.

The use of coupled states has two advantages. First, the sequence of coupled states in a woman's sample path preserves the *number* and the *order* of transitions from age 15 up to the time of interview. Second, the sequence of coupled states along with the order of transition preserves the past history of transitions; that is, we know through which path a specific coupled state was reached. In other words, the transition probabilities considered here are probabilities involved in a non-Markovian system of transitions.

The duration-dependent probability of transition from one coupled state to another in a non-Markovian set-up can be described as

$$P\{X_{Mn} = i, X_{Pn} = j, Y_n \le t \mid (X_{Mn-1} = k,\ X_{Pn-1} = l), w_{n-2}\} = B^{n}_{kl,ij}(t)$$

This is a probability associated with a direct transition from the coupled state (k,l) to the coupled state (i,j) in t or less time units as the n-th step, given the past history w_{n-2}. This probability is a one-step transition probability from which, as in renewal theory, duration-stay probability and mean length of stay in a state can be derived (for details, see Mode, 1985). We shall, however, focus our attention on the one-step transition probabilities.

In working with the model, a few practical decisions are made: (a) When a specific transition, described by order and sequence, is made only by a handful of women, transition probabilities can become erratic and unreliable and are, therefore, interpreted with caution. Even though the probabilities themselves are unreliable because they have been calculated from a small number of cases, the overall pattern revealed by them may still be informative. (b) As previously mentioned in order to avoid small numbers, we ignore the heterogeneity introduced by age at (*n-1*)-th transition. (c) An examination of the data reveals that separations are predominantly followed by legal divorce; therefore, we exclude the state DIV. (d) Since we are interested in the interdependence of marital and parity states, the study is confined to transitions up to STER or TBIR; the sequences following them are not presented here.

In order to determine the number of transitions (*n*) to be considered for analysis, the observed frequencies of transitions and the number of women censored in each transition were examined in detail. The results (not shown here) revealed that at least two transitions for the youngest cohort and four for the oldest cohort can be analyzed.

Results

Once the data on the sample path of each woman have been retrieved from her marital and fertility histories, the one-step transition probabilities can be constructed from each coupled state duly taking into account the censored cases. For an illustration on the arrangement of data and calculation of probabilities corrected for censoring, see Rajulton and Lee (1988).

The First Transition since Age 15

Table 2 presents the probabilities of transition from the SING state of the three relevant destinations. The interpretation of these probabilities is straightforward; they are probabilities of making a direct (one-step) transition from the single state by a given duration. For example, one finds, in the case of the youngest cohort aged 18-24 at the time of survey, the probabilities 0.01, 0.08 and 0.28 of transiting from the single state entered at age 15 to the cohabitation state within one, three and six years, respectively. It is helpful to interpret these probabilities as percentages; for example, 41 per cent of women aged 18-24 moved to cohabitation state by nine years, that is, before they were aged 24. These first passage probabilities for each duration reveal the partial intensities and tempos of transition to a specific destination state.

Clearly, the patterns of one-step transitions have significantly changed over cohorts, either in intensities or tempos or in both. *The most conspicuous change over cohorts is found in the very first transition in reproductive or marital life*, namely the direct transition made from the single state entered at age 15. While 86 per cent of women in the oldest cohort made their first direct transition to the married state before they were age 30 (duration 15), only 58 per cent of women in the mid-cohort 25-34 made this direct transition for the same

TABLE 2. CUMULATIVE PROBABILITIES OF FIRST TRANSITION FROM THE STATE SING (SINCE AGE 15) TO THE STATES FCOH, FMAR AND FBIR

Cohorts		18-24			25-34			35-49	
	FCOH	FMAR	FBIR	FCOH	FMAR	FBIR	FCOH	FMAR	FBIR
Duration									
1	.013	.001	.007	.005	.005	.004	.000	.014	.003
2	.039	.007	.014	.017	.016	.012	.001	.036	.007
3	.075	.020	.021	.034	.050	.020	.003	.081	.015
4	.159	.053	.030	.076	.112	.028	.006	.157	.020
5	.233	.096	.032	.127	.191	.037	.013	.271	.027
6	.280	.143	.038	.167	.288	.042	.018	.388	.031
7	.338	.183	.039	.206	.375	.046	.025	.518	.035
8	.381	.233	.039	.239	.434	.047	.032	.625	.041
9	.408	.266	.039	.259	.476	.049	.039	.693	.043
10	.439	.288	.039	.278	.501	.049	.042	.738	.044
11				.292	.528	.050	.047	.769	.047
12				.302	.544	.051	.050	.797	.047
13				.308	.555	.051	.053	.810	.047
14				.313	.559	.051	.055	.823	.048
15				.331	.578	.052	.068	.860	.053

number of duration years. If we compare the cohorts over nine years of duration (that is, by age 24), the corresponding percentage decreases from 69 to 48 to 27 over cohorts. This significant decrease in the percentage of women making their first transition to the married state can be set in contrast to the increasing percentages of transition to cohabitation from older to younger cohorts. For a duration of nine years, these probabilities have increased ten-fold, from 0.04 in the oldest cohort to 0.41 in the youngest. Older women might have withheld information on transition to cohabitation inasmuch as cohabitation would not have been considered an acceptable behaviour among them. While this is possible, the differences among the birth cohorts are so large that it is reasonable to assume a real change in behaviour over cohorts. In other words, among the younger cohorts, cohabitation may be replacing marriage as the first state entered by single women when they start their marital/reproductive life. This is further highlighted in Figure 1, which contrasts the first passage probabilities of transition to the married state with those to cohabitation state. While patterns of transition to first marriage and cohabitation have changed, those of direct transition to first birth after age 15 have not changed at all over cohorts; thus, at duration 9, for example, Table 2 shows that the probabilities have remained at just about 0.04 or 0.05 for the three cohorts.

The Second Transition in Marital/Reproductive Life

Table 3 presents the non-Markovian probabilities of the second transition made from the states SING-FCOH, SING-FMAR and SING-FBIR to two or three predominant destination states for selected years of duration. First, let us consider the transition made from SING-FCOH. Women who entered cohabitation can now get married or have first births in cohabitation or get sterilized. The probabilities in Table 3 reveal that these women move predominantly to married state and do so sooner than later; however, decreasingly so for the youngest cohort whose probabilities become "asymptotic" or stable by seven years under the prevailing tempo and intensity (given in the table under the column "as"). Women in the youngest cohort (41 per cent of whom entered cohabitation straight from the single state; Table 2) would take a longer time to marry compared to their older counterparts. Instead, an appreciable proportion (34 per cent) would have first birth in cohabitation. The summary measure – mean length of stay (given in the last column of the table) – does not bring out this difference among cohorts; only detailed duration-specific probabilities do.

Women who moved to the married state as their first transition can make their second move either to separation or to first birth or to sterilization. The

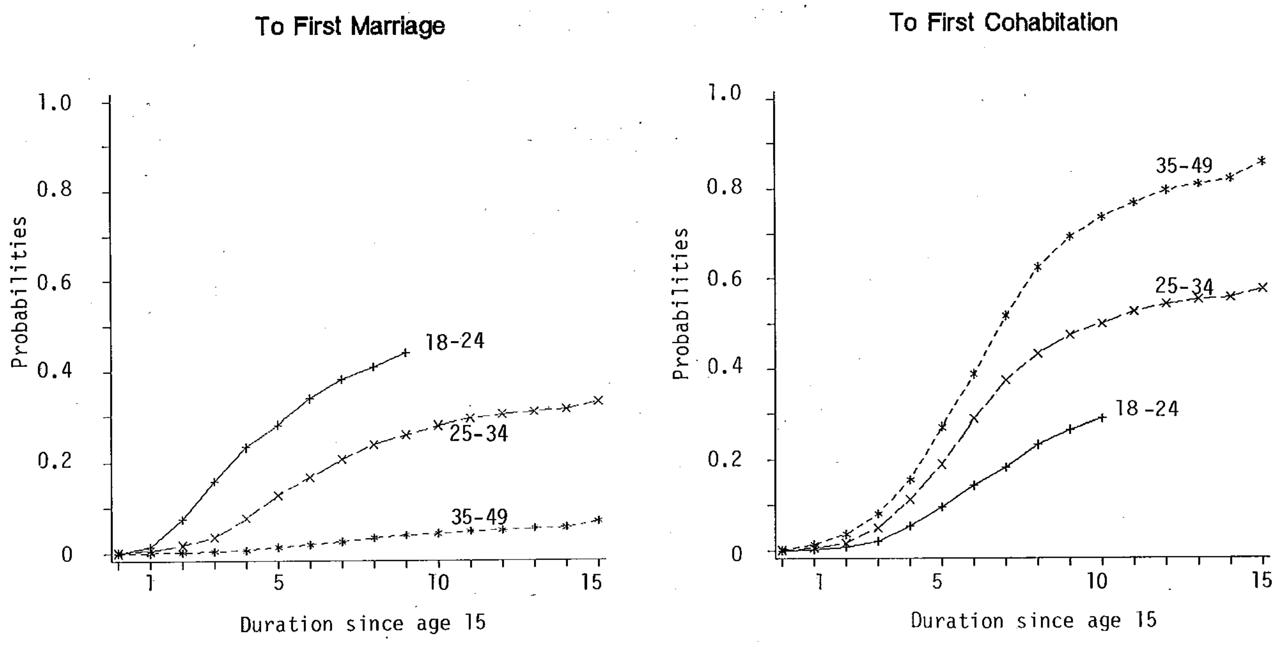

FIGURE 1. ONE-STEP PROBABILITIES OF TRANSITION FROM THE SINGLE STATE TO THE MARRIED AND COHABITATION STATES, CLASSIFIED BY COHORTS

TABLE 3. NON-MARKOVIAN PROBABILITIES OF THE SECOND TRANSITION FROM THE RESPECTIVE COUPLED STATE ENTERED THROUGH THE FIRST TRANSITION, BY BIRTH COHORTS, CFS 1984

	Duration 1	2	3	4	5	6	7	as*	Mean-length (for 7 yrs)
SING-FCOH-FMAR :									
18-24	.04	.17	.26	.32	.36	.40	.46	.46	
25-34	.12	.28	.38	.46	.52	.56	.59	.70	
35-49	.11	.27	.36	.41	.47	.49	.52	.59	
									3.74
SING-FCOH-FBIR :									3.27
									3.47
18-24	.04	.08	.15	.19	.23	.27		.34	
25-34	.07	.10	.12	.14	.15	.16		.21	
35-49	.02	.07	.11	.13	.14	.15	.16	.20	
SING-FMAR-SEP :									
18-24	.01	.02	.05	.07				.07	
25-34	.00	.02	.02	.03	.04	.05		.06	
35-49	.00	.01	.01	.01	.02			.03	

SING-FMAR-FBIR :									
18-24	.19	.42	.58	.71	.75	.77		.77	2.43
25-34	.20	.37	.52	.65	.74	.78	.81	.86	2.68
35-49	.30	.56	.70	.77	.82	.85	.87	.91	2.01
SING-FBIR-FCOH :									
18-24	.20	.30	.35	.35	.40			.40	
25-34	.08	.12	.14	.17	.17	.19		.23	
35-49	.05	.05	.07	.09	.12	.14		.16	
SING-FBIR-FMAR :									
18-24	.11	.17	.24	.27	.27	.33		.33	2.36
25-34	.28	.39	.47	.49	.51	.57	.58	.58	2.02
35-49	.31	.43	.49	.55	.56	.57	.58	.60	1.72
SING-FBIR-SBIR :									
18-24	.00	.02	.04	.04	.10	.10	.22	.22	
25-34	.03	.04	.07	.09	.11	.11	.12	.15	
35-49	.03	.07	.15	.16	.18			.18	

* "as" denotes asymptotic probabilities

relevant probabilities of separation and first birth are given in the second panel of Table 3. Three to seven per cent of these women become separated and around 80 per cent follow the normal experience of having their first birth in marriage. Women in the youngest cohort have births somewhat earlier than women in the mid-cohort, which may be attributed to the selectivity of these women since we have not taken into account age at entry into married state. The final proportions of women who have their first births in marriage are not very different in the case of women aged above 25; and, as seen above, a good proportion of women aged less than 25 have first births in cohabitation. Thus, the second transition alone indicates that childlessness is less likely if the first transition is to the married state; childlessness seems to be more prevalent among cohabiting women than among the married. However, this needs to be examined with later transitions.

Probabilities of single mothers transiting to cohabitation or to marriage or to second birth are presented in the third panel of Table 3. The observed numbers of single mothers who make these transitions are rather small, especially in the youngest cohort. Interpretations, therefore, have to be made with caution. Given the trend already noted, it is not surprising that single mothers in the youngest cohort transit predominantly to cohabitation (40 per cent by five years of duration), and next to married state (33 per cent by six years). Among older women, the pattern is essentially different; their predominant move is to marriage.

The Third Transition in Marital/Reproductive Life

When we consider the third transition from various origin coupled states, 22 different types of transitions are meaningful, but for simplicity we present in Table 4 the associated probabilities of only the more frequently occurring transitions. An appreciable number of women have made a SING-FCOH-FMAR transition (Table 3). These women can make their third move either to separation or to first birth. Very few women, however, become separated; therefore, Table 4 presents only the probabilities of first births in marriage preceded by cohabitation. Even though the youngest cohort has not had enough time within the available duration-years (four years at the maximum), 75 per cent of them go on to have their first births, as compared to 69 per cent and 54 per cent for older cohorts for the same duration. The youngest cohort is typically characterized by higher tempos. The definite trend in the type SING-FCOH-FMAR-FBIR transition was set by women belonging to the 25-34 cohort; the youngest cohort simply reflects the acceleration of this trend.

A comparison of women who pass through cohabitation and marriage before having first births (in Table 4) with those who pass through marriage only (in Table 3) reveals a few striking differences. In the two younger cohorts, almost the same asymptotic values are found, but the tempo of transition is higher among those who pass through cohabitation. (Once again, age may be playing its role.) In addition, an entirely reverse picture emerges in the case of the oldest cohort: those who passed through cohabitation have consistently lower probabilities for all durations. If first births take place in marriage preceded by cohabitation, then the tempo of transition to first birth is accelerated among younger women. The time lag involved in making two transitions before first birth may be an explanation. However, changes in norms and acceptance of new marital patterns may be a better explanation. Mean lengths of stay in SING-FCOH-FMAR state are also given in the table; the youngest cohort has the least mean value.

Women who transit first to cohabitation and have first births in cohabitation are likely to experience one of these two main events as their third transition: a second birth or marriage. The associated probabilities are given in the second panel of Table 4. Even though small numbers should make us cautious about the reliability of these probabilities, the pattern involved indicates at least one common point for all cohorts: if these women do not get married by two to three years after first birth, second births in cohabitation are more likely than a transition to the married state. Cohabiting women continue childbearing in cohabitation as much as those in marital union do. However, the final proportion who would have their second births is less among cohabitants than among the married (shown in the next section).

The case of those women who got married and then separated is shown in panel 3 of the table. These probabilities show that there is at least a 40 per cent chance that cohabitation follows separation. The mean length of stay in separation has remained virtually the same over the two older cohorts.

Considering the normal path which women are expected to take, it is clear that first birth in marriage is followed sooner rather than later by second birth in marriage (panel 4). About 80 per cent of women in all cohorts will move from parity one to parity two by five years since first birth; and the tempo only slightly varies over cohorts. The second birth interval (roughly indicated by the mean length of stay) is 2.5 years, almost unchanged over cohorts. In other words, we can say that both the intensity and tempo of second birth in marriage are virtually unchanged over cohorts. (The youngest cohort with higher tempos after two or three duration-years is surely a case of selectivity, given the small number of cases.) As well, first births followed by separation is a rare phenomenon, even though the probabilities have doubled over cohorts.

TABLE 4. NON-MARKOVIAN PROBABILITIES OF THE THIRD TRANSITION FROM THE RESPECTIVE COUPLED STATE ENTERED THROUGH THE SECOND TRANSITION, BY BIRTH COHORTS, CFS 1984

	Duration 1	2	3	4	5	6	7	as*	Mean-length (for 7 yrs)
SING-FCOH-FMAR-FBIR :									
18-24	.31	.57	.71	.75				.75	1.54
25-34	.24	.44	.57	.69	.75	.79	.83	.86	2.27
35-49	.18	.34	.43	.54	.62	.65	.66	.72	3.12
SING-FCOH-FBIR-SBIR :									
18-24	.00	.14	.23	.38	.47	.59		.59	
25-34	.01	.17	.25	.33	.35	.36	.38	.43	
35-49	.12	.26	.42	.42	.47			.47	
									2.74
SING-FCOH-FBIR-FMAR :									2.99
									2.12
18-24	.12	.25	.29	.33				.33	
25-34	.12	.20	.24	.30	.34	.39	.41	.41	
35-49	.14	.18	.22	.22	.26	.31		.31	
SING-FMAR-SEP-FBIR :									
18-24	.00	.61						.61	
25-34	.06	.06	.12	.14	.14	.14	.19	.25	
35-49	.09	.14	.18	.23	.27	.27	.32	.32	

SING-FMAR-SEP-FCOH :									1.13
									3.28
18-24	.13	.13	.39					.39	3.21
25-34	.10	.27	.38	.43	.53			.53	
35-49	.12	.19	.28	.32	.34	.38		.38	
SING-FMAR-FBIR-SBIR :									
18-24	.02	.25	.59	.72	.81	.89		.89	
25-34	.01	.26	.54	.70	.77	.82	.84	.86	
35-49	.05	.36	.60	.74	.80	.83	.84	.88	
SING-FMAR-FBIR-SEP :									2.50
									2.72
18-24	.05							.05	2.55
25-34	.01	.03	.03	.05	.06			.06	
35-49	.00	.01	.01	.02				.03	
SING-FBIR-FMAR-SBIR :									
18-24	.25	.47	.74	.86	1.00			1.00	1.67
25-34	.22	.40	.55	.63	.66	.72	.74	.75	2.37
35-49	.21	.50	.69	.76	.81	.81	.82	.89	1.92

* "as" denotes asymptotic probabilities

The last case of interest (panel 5) is second birth in marriage following first birth out of marriage (as single mothers). The probabilities of second births are once again very high, even though there seems to be a decline in the case of women aged 25-34.

Births Followed by Typical Sequences

The above results provide a detailed analysis of type and timing of transitions and of the changes over time in nuptiality and fertility behaviours of Canadian women. The results are somewhat voluminous, as in any multistate analysis. As a way of summarizing the various points discussed above, we can focus our attention on probabilities of incidence of births (of order one to three) associated with different types of transitions. For simplicity, we shall consider a maximum of four transitions and illustrate in detail how to calculate the probabilities of incidence of first births from the non-Markovian probabilities of each transition seen above. Similar calculations can be done for births of higher order. .

First birth occurs through one or more transitions. Single women give birth, and we already know the probabilities of such occurrences (Table 2). Women get married or cohabit, and then have their first births; we know the corresponding probabilities, as well (Table 3). Or, women can make three or four transitions before having their first births; the probabilities associated with the former are found in Table 4. These (non-Markovian) probabilities of sequences of transitions enable us to chain all these events and, through an elementary rule of probability, find the probability of incidence of first births through a variety of paths women can take. For example, what is the combined probability that a woman cohabits for five years, then gets married and has her first birth at a marital duration of two years? What is the probability that a single mother cohabits for a duration of three years and has her second birth? Though such detailed analyses are possible with any point on the duration scale for any type of sequence of transitions, we shall deal with the asymptotic probabilities, both for the sake of simplicity of presentation and for a comparison over cohorts.

The (asymptotic) probabilities of first births experienced by single women are obtained straightaway from Table 2: 0.04, 0.05 and 0.05 from younger to older cohorts. Probabilities of first birth following a transition to cohabitation are obtained by multiplying the probabilities of making a transition to cohabitation (0.44, 0.33 and 0.07, respectively, from Table 2) with the probabilities of occurrence of first birth in cohabitation (0.34, 0.21 and 0.20, respectively, from Table 3). Thus, the required probabilities are 0.15, 0.07

and 0.01 for respective cohorts. In the same manner, the probabilities of first birth in the sequence of SING-FCOH-FMAR-FBIR are obtained by the multiplication of successive probabilities of making a transition from SING to FCOH, from FCOH to FMAR and from FMAR to FBIR; for example, in the case of the youngest cohort, 0.44 x 0.46 x 0.75 (from Tables 2, 3 and 4), resulting in a combined probability of 0.152. Extension to higher orders is straightforward. The relevant probabilities of births (of order one to three) preceded by selected typical sequences of transitions are given in Table 5 and diagrammatically represented in Figure 2.

Probabilities of births arranged this way adequately summarize the previous section, bringing out the changes over cohorts in the interdependence of nuptiality and fertility behaviours. As the results indicate, changes in fertility behaviour run parallel to changes in marital behaviour. In the case of first births, for example, among women belonging to the oldest cohort 35-49, 87 per cent (0.783 divided by 0.900)[3] of first births followed the normal pattern of births in marriage. Next was first births occurring to single women (6 per cent), which is a considerable proportion given the fertility norms of the times when women of this cohort began childbearing.

Changes brought about soon after the world war are reflected in the probabilities of first births in the case of women belonging to the cohort 25-34. The highest proportion (58 per cent) of first births still takes place in marriage and following marriage, but the reduction in this proportion as compared to that of the oldest cohort is remarkable. First birth occurring in marriage via cohabitation assumes the next highest proportion (23 per cent). Both these proportions add to give approximately the proportion that was found in the oldest cohort (81 versus 87 per cent). Thus, about 29 per cent (0.199/(0.199+0.499)) of women who would have married and given birth in marriage deviate from the norm to pass through cohabitation instead. In addition, 8 per cent (0.069/0.86) of births would take place in cohabitation itself; and, as was mentioned in an earlier context, the percentage of first births experienced by single women remains constant at 6 per cent, even for the youngest cohort.

First births experienced by women of the youngest cohort need special attention. Though they have not had as much time to experience first birth as women in the older cohorts, the changes initiated by the mid-cohort are more deeply felt by women of this cohort. Only 39 per cent (0.223/0.578) of first births take place following first marriage. An appreciable 26 per cent of births are experienced by women who pass through cohabitation before marriage, as it was in the mid-cohort, but more remarkably, another 26 per cent of births take place in cohabitation itself. One can visualize the trend that has set in

TABLE 5. COMBINED PROBABILITIES OF BIRTHS OF ORDER ONE TO THREE THROUGH A SEQUENCE OF TRANSITIONS, BY BIRTH COHORTS, CFS 1984

No. of trans.	Types	Cohorts 18-24	25-34	35-49
	a) First births :			
1	SING-FBIR	.039	.052	.053
2	SING-FCOH-FBIR	.149	.069	.014
	SING-FMAR-FBIR	.223	.499	.783
3	SING-FCOH-FMAR-FBIR	.152	.199	.030
	SING-FMAR-SEP-FBIR	.001	.009	.008
4	SING-FCOH-FMAR-SEP-FBIR	.007	.018	.005
	SING-FMAR-SEP-FCOH-FBIR	.007	.014	.007
Total		.578	.860	.900
	b) Second births :			
2	SING-FBIR-SBIR	.009	.008	.009
3	SING-FCOH-FBIR-SBIR	.088	.030	.007
	SING-FMAR-FBIR-SBIR	.199	.414	.667
	SING-FBIR-FCOH-SBIR	.002	.003	.002
	SING-FBIR-FMAR-SBIR	.013	.022	.027

4	SING-FCOH-FMAR-FBIR-SBIR	.081	.165	.023
	SING-FCOH-FBIR-FMAR-SBIR	.032	.024	.003
	SING-FMAR-SEP-FBIR-SBIR	.000	.006	.004
	SING-FMAR-FBIR-SEP-SBIR	.004	.007	.007
	SING-FBIR-FCOH-FMAR-SBIR	.006	.006	.003
	SING-FBIR-FMAR-SEP-SBIR	.000	.001	.000
Total		.434	.686	.752
	c) Third births :			
3	SING-FBIR-SBIR-TBIR	.000	.000	.001
4	SING-FCOH-FBIR-SBIR-TBIR	.061	.011	.003
	SING-FMAR-FBIR-SBIR-TBIR	.098	.195	.413
	SING-FBIR-FCOH-SBIR-TBIR	.002	.002	.000
	SING-FBIR-FMAR-SBIR-TBIR	.003	.012	.018
	SING-FBIR-SBIR-FCOH-TBIR	.000	.001	.000
	SING-FBIR-SBIR-FMAR-TBIR	.002	.000	.006
Total		.166	.221	.441

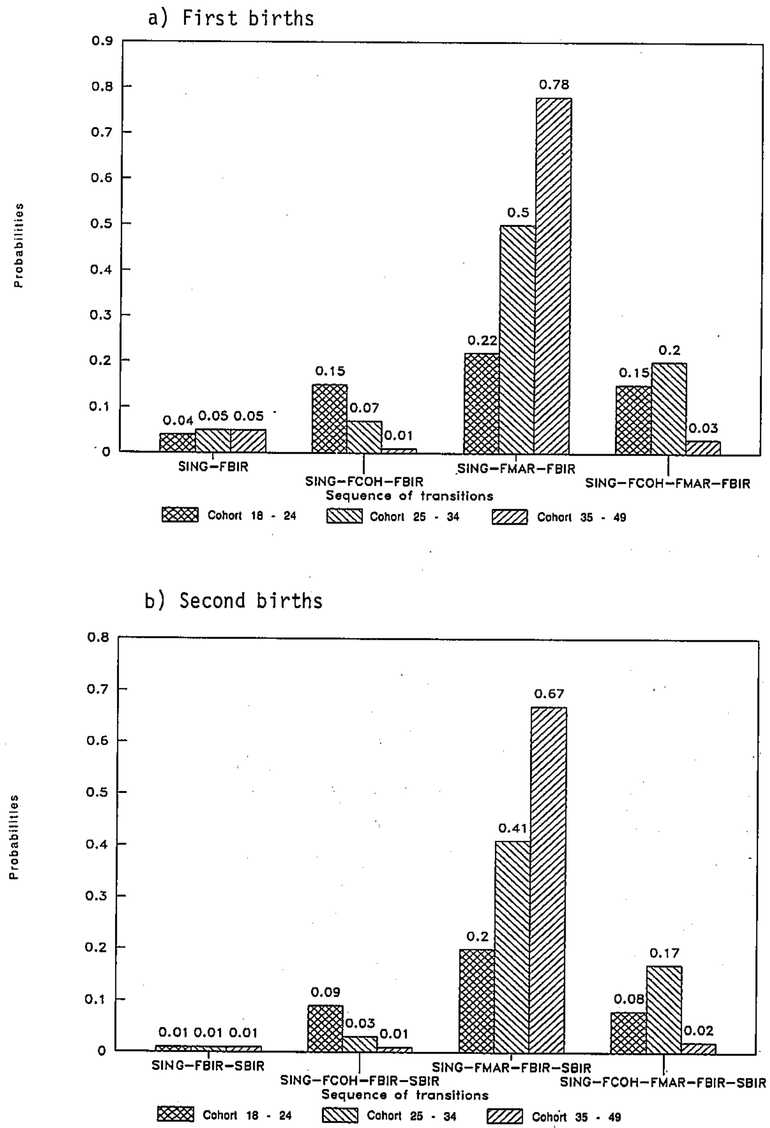

FIGURE 2. PROBABILITIES OF FIRST AND SECOND BIRTHS THROUGH A SEQUENCE OF TRANSITIONS

as follows. About 40 per cent of births to women who have started childbearing in recent times takes place in the traditional manner; that is, women get married and then have first births. This 40 per cent is flanked on either side by a new lifestyle of cohabitation: about 52 per cent of first births will occur through cohabitation as one of the transition types, either in cohabitation itself or as a pre-stage to marriage.

The above finding calls for modifying inferences made by many earlier studies on cohabitation, namely that it merely serves as a pre-stage to marriage. No longer so. Cohabitation (among Canadian women) has come to be accepted and serves equally as a threshold to first birth as it was to marriage. An examination of higher order births further confirms this. While 89 per cent of all second births to women in the oldest cohort happened following first births in marriage, this proportion reduces to 60 per cent in the mid-cohort, 24 per cent being taken by the sequence SING-FCOH-FMAR-FBIR-SBIR, a repetition of the same pattern as was observed in the case of first births. In the youngest cohort, the normal pattern covers about 46 per cent of all second births, once again flanked on either side equally (20 per cent) by transitions through cohabitation. All other types of transitions before second births become negligible.

Third births occur only or predominantly to women who have followed the normal path of fertility in marriage. This means that higher order births, if they take place, will be mostly restricted to women who follow the normal way of going through marriage first. Cohabitation, followed by marriage or not, results in lesser probabilities of third births.[4]

Summary and Conclusion

Application of stochastic processes to fertility analysis is necessary in order to understand and examine the variations in tempo of childbearing in the context of stabilized fertility levels in industrialized countries. This paper exemplifies a few analytical possibilities of working with maternity histories through a non-Markovian framework. In doing so, the technique of life tables, most familiar to demographers, has been used and it is shown how best to exploit the information provided by marital and birth histories.

From the data on marital and birth histories, we constructed probabilities of transiting among the states in a system of two interdependent subsystems. We introduced the non-Markovian framework at the expense of details on heterogeneity due to age at previous transition and considered the influence of past history on the probabilities of transitions. This type of analysis throws light on the transformations which have taken place in Canadian society, as far as marital/reproductive life is concerned.

The most conspicuous change in Canadian family formation is the delay in entering into a legal union. Age at first marriage has dramatically increased; by age 24, only 27 per cent are married in the youngest cohort compared to 70 per cent in the oldest. It may well be due to increased education of women, greater probability of entry into the labour force and a decline in the norm of early and universal marriage as a prerequisite for a happy life. Our data show, however, that this does not mean that women devalue intimate personal relationships. The proportion of those who enter some union has practically remained the same. Increase in cohabitations has compensated for the decline in marriages in the younger ages. Whether cohabitation is a prelude to marriage or is a new form of living arrangement is still a moot question. Rapid increase in cohabitation is probably no more than a facet of the secular changes occurring in Canadian society, such as liberalization of divorce laws, acceptance of premarital sex, and emphasis on individual freedom and choice.

The important demographic consequence of cohabitation in place of legal marriage is in the reduction of fertility levels. While we find some evidence that cohabitation does not inhibit the birth of the first child, subsequent parities are rare among cohabiting women. It may well be that the roles of wife and mother are seen as more closely linked than the roles of cohabiting partner and a child, by the very nature of the less stable relationship in a cohabitation. It may also be that while in the past a pregnancy may have led to a marriage, in present times it may only lead to a cohabitation which may or may not precede a legal marriage. Social norms now are more accepting of a birth before marriage. Among younger women, not only living arrangements take more complex forms, but childbearing is becoming more independent of marital status, at least at first parity.

We have focussed our attention in this paper on the cohort differentials in types and timing of transitions among marital and parity states. Further differentials can be explored by parametrizing the one-step transition probabilities with the information on socioeconomic characteristics. This is a task which we hope to do in the near future.

Footnotes

1. These are also referred to in the text as *tempo* and *intensity*, terms more commonly encountered in French demographic literature and carrying technical connotations of mean age and mean number of events *relative to the initial size of the cohort* under consideration.

2. A few women were not able to recall the month of surgical operation. To these women, an average of six months of exposure in the year of the operation is given in the calculation of duration in the state from which they transit to STER.
3. A caution is in order here. The sum of the combined probabilities should not be confused with the "parity progression ratio" as normally understood in demographic analysis. For example, the total probability 0.900 in the case of women aged 35-49 *does not mean* that 90 per cent of women would progress from parity zero to parity one. On the contrary, it is the sum of probabilities of experiencing first births through various (mutually exclusive) types of transitions, *both among marital and parity states*. It is not simply a straightforward transition from one parity to another.
4. Note that in the youngest cohort, women going through the sequence SING-FCOH-FBIR-SBIR-TBIR make up about 37 per cent of the total third births, because the other sequence SING-FCOH-FMAR-FBIR-SBIR-TBIR is absent here, which needs to consider a fifth order transition. In any case, third births in the youngest cohort are very unlikely, not only because of drastic decline in higher parities but also because these women have not had enough time to complete their fertility.

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Received July, 1989; revised July, 1990